Client-side Data Processing and Training for Multispectral Imagery Applications in the GOES-R Era

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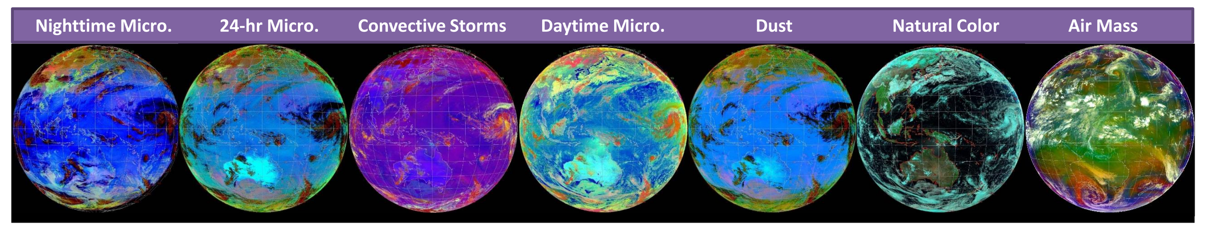
NASA SPoRT Short-term Prediction Research and Transition

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Introduction

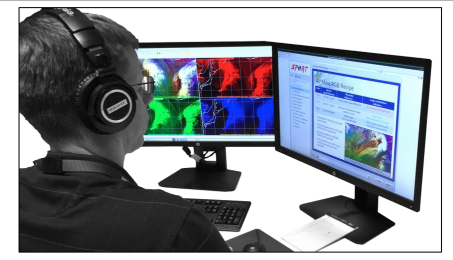
- Multispectral (i.e. RGB) imagery products from GOES-R/ABI are anticipated given the demonstrated capabilities from MSG/SEVIRI (2004) and H-8/AHI (2015) instruments.
- EUMETSAT developed at set of standard RGB imagery products that are internationally accepted.

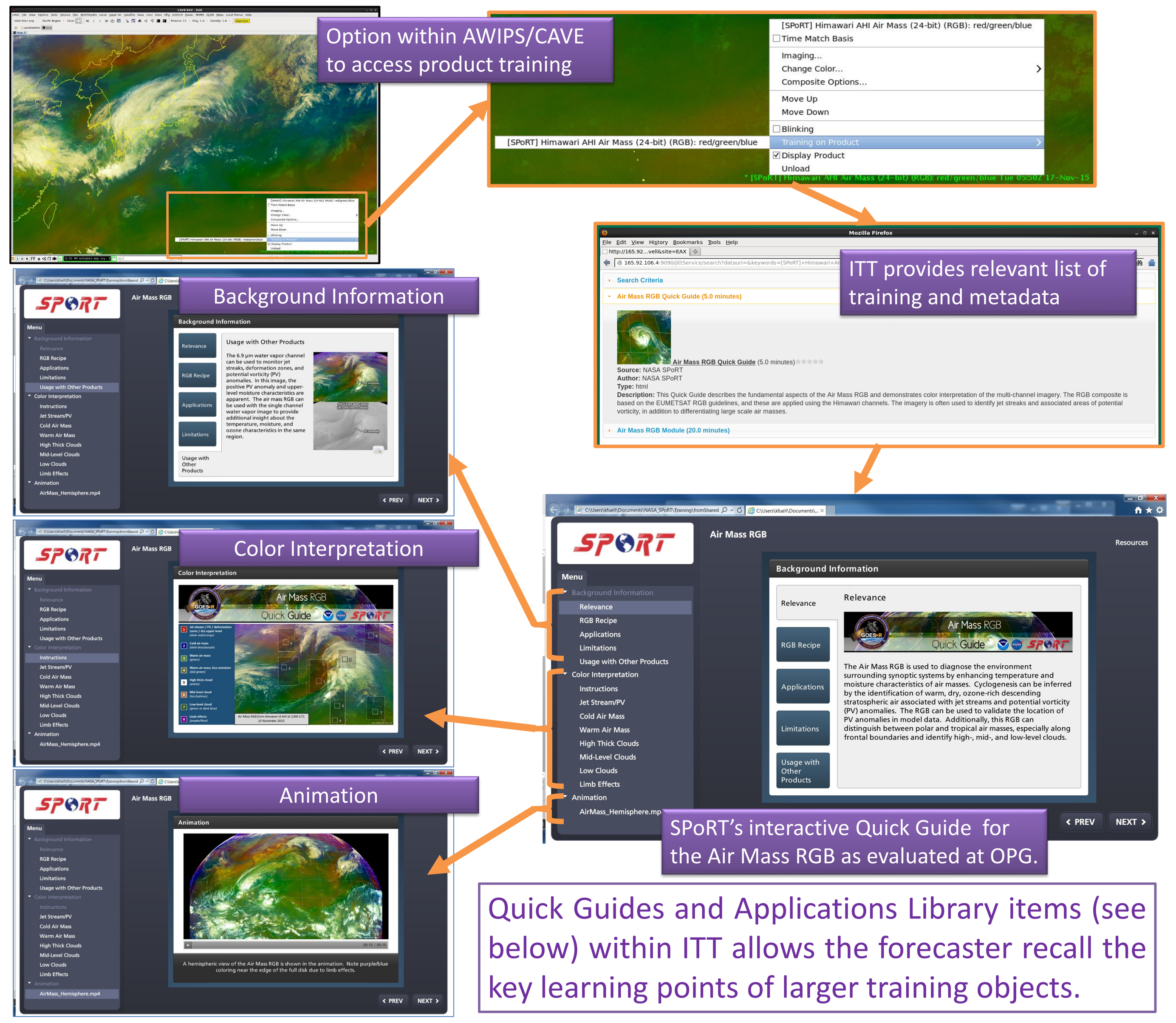


- SPoRT adopted the standard RGBs for use with MODIS, VIIRS, and AVHRR as part of its funded NOAA Satellite Proving Ground efforts to prepare users for GOES-R.
- NWS projects all channels from GOES-R will be locally available on the forecasters display system, thus allowing RGB imagery products to be created on the "client-side" verses centrally processed and delivered separately.
- U.S. forecasters are largely unfamiliar with RGB imagery from infrared-based channels and RGB interpretation represents a new paradigm of imagery applications.
- **A demonstration by the NWS Operations Proving Ground (OPG) examined the feasibility of locally generated RGB imagery, the user's perceived value of RGBs, and the use of a SPoRT-developed tool to provide RGB training and reference materials within the product display system.**

Integrated Training Tool for AWIPS

The Integrated Training Tool (ITT) prototype was presented at the 2015 Satellite User Readiness meeting and became an action item endorsed by the NOAT, funded by GOES-R, and developed by SPoRT, and later tested at OPG in Spring 2016.

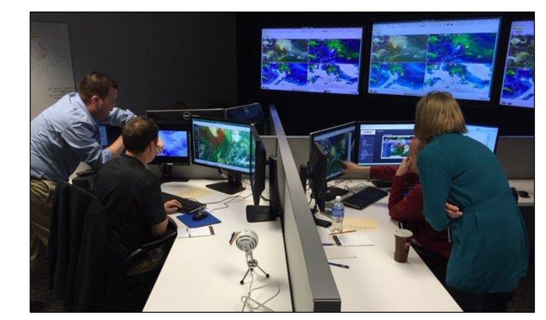




Quick Guides and Applications Library items (see below) within ITT allows the forecaster recall the key learning points of larger training objects.

OPG Demonstration

- NOAA NWS Operations Proving Ground (OPG) sponsored a demonstration ***"Evaluating Operational Applications of Multispectral Bands for the GOES-R Era"***
- ***Primary Goal:***
  - Analyze Himawari-8 imagery to gain insight into which spectral bands, channel differences, and/or multispectral imagery offers most operational value in the opinions of the forecasters.
- ***Secondary Goals:***
  - Assess forecasters' ability to understand/interpret RGB imagery for various diagnostic tasks, after limited exposure
  - Obtain feedback on the usefulness/effectiveness of AWIPS Integrated Training Tool
  - Evaluate impact of client-side RGB generation on AWIPS system performance and forecaster workflow



Workstation Performance

- Caveat: RGBs were generated used 2-km full disk imagery
- Table 1 shows how AWIPS errors were reduced each week as the configuration was changed

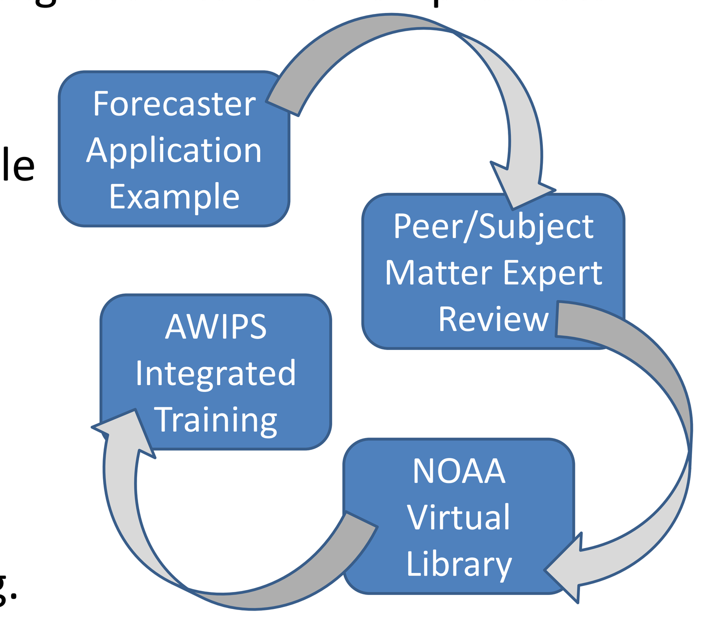
Table 1	Texture Cache	Java VM Heap Size	Errors
Week 1	512 MB	1024 MB	+370
Week 2	512 MB	4.096 GB	+240
Week 3	2.048 GB	6.144 GB	19*
WFO Refresh	1 GB	6 GB	

** One workstation first exercise*

- Week 3: Forecasters discussed workstation performance was similar to what they experience at their local WFO.
- **The OPG technical staff recommends increasing CAVE texture cache to 2 GB for better workstation performance**

OPG Recommendations

- Due to the complexity of some RGB composite imagery, *initial widespread* NWS exposure to RGBs should focus on recipes and best practices developed by EUMETSAT, adopted by the WMO, and that have been demonstrated within the Satellite Proving Ground.
- The development of GOES-R applications training needs to utilize experts from National Centers and operational field offices in order to integrate spectral bands, spectral differencing, RGBs, and derived products with datasets forecasters already use for operational decision making.
- The development of training devoted to assisting forecasters in understanding and applying less intuitive RGB products needs to be a priority.
- The development of an applications library accessible via AWIPS or VLab that includes short, focused regional and local examples illustrating how satellite imagery can have a direct, positive impact on operational decision making.



Client-Side Processing

- The internationally-recognized "best practices" RGBs by EUMETSAT include band differences as well as fixed ranges and contrast stretching per color component. These calculations, range thresholds, and stretching require the use of AWIPS II derived parameters and additional code.
- SPoRT's Experimental Products Development Team (EPDT) members (including CIRA and NWS) developed Python code to assign a specific range and contrast stretching to each RGB product recipe.
- If all bands are available, the EPDT code can locally derive recipe-based, 24-bit RGB images on demand.

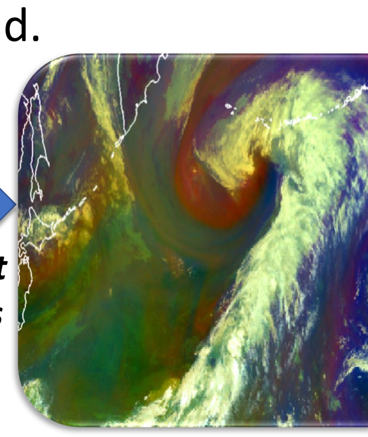
Database → Python Code → 24-bit Visualization

8-bit Single-Channel Data

Python Code
Example: AHI Air Mass Recipe

	Bands	Range	Gamma
R:	6.2 – 7.3 µm	-25 to 0 K	1.0
G:	9.6 – 10.4 µm	-40 to 5 K	1.0
B:	6.2 µm	243 to 208 K	1.0

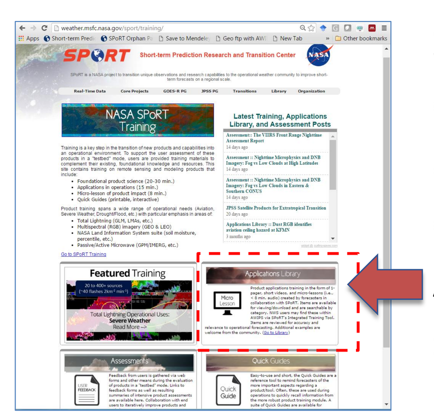
3x8-bit Arrays



24-bit Visualization

- AWIPS II has the capability to create simple, composite R-G-B products through the TrueColorViz Plugin, but these composites do not provide min and max thresholds or contrast stretching needed for each color component. Hence, the composite interpretation is not consistent over time.

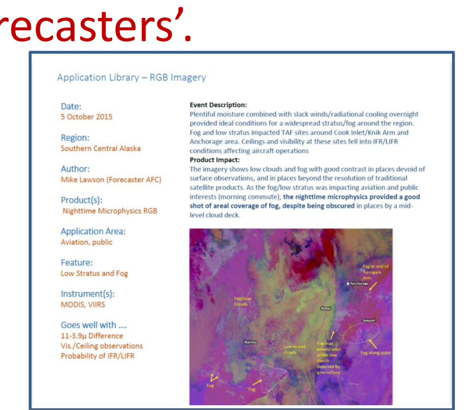
SPoRT's Applications Library



SPoRT's training work includes the collaboration with forecasters to capture application examples to share with the community. These are placed in an Applications Library to create a resource of short, reference training that is 'by forecasters, for forecasters'.

Application Library Templates

"1-minute" Resource: Very quick example of product application and impact (*i.e. 'Picture and a Paragraph'*). Great for regional examples.



Example of "1-minute" Resource

"3-minute" Video/Animation: Analogous to a "how-to" video on YouTube or similar sites. Incorporates multiple images and/or animations. Solid example of product application with other resources.

"8-minute" Micro-lesson: Very focused on application aspect to build on foundational training. Could be done on "quiet" shift and easily referenced later. Examples derived from collaborate product assessments where forecasters provide feedback.

Examples of 8-minute" Micro-lessons

- Objects will be accessible to AWIPS-ITT via NWS Virtual Laboratory (Vlab)
- Items are to be peer reviewed by 3-forecaster panel, training designer, and product expert.

Feedback: Integrated Training

- ***"On a scale of 1-10....a 100...It's a way for forecasters to continually be able to reference the building blocks and apply those building blocks to applications and the forecast process..."***

Air Mass RGB module and Quick Guide demo'd at OPG

OPG Question: When learning how to interpret the Air Mass RGB, how valuable was it to view the Air Mass RGB Module and Interactive Quick Guide in AWIPS during this exercise to reinforce foundational RGB concepts learned before arriving at the evaluation?

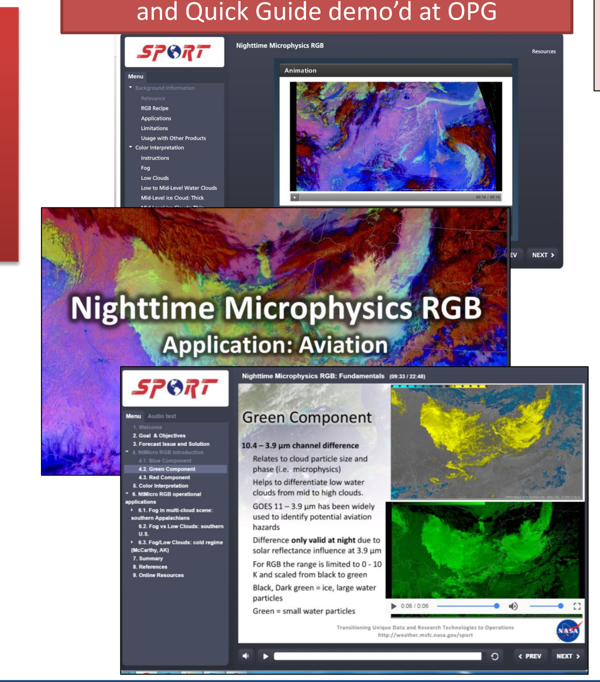
"__I think this is great to have integrated right into the AWIPS workstation__. However, the __module__ can take some time to go through and __may not be good to do during a busy shift or when there is the potential for high impact weather__. This is __why I think quick guides are crucial to have as a resource__."

Ranking (1-10) (10 as Extremely Valuable)	Training Module
10	6
9	1
8	1
6	1

OPG Question: When learning how to interpret the Nighttime Micro RGB in this exercise, how valuable was it to view each type of training in AWIPS to reinforce foundational RGB concepts learned before arriving at the evaluation?

Ranking (1-10) (10 as Extremely Valuable)	Intro. Module	Application Module	Interactive Quick Guide
10	3	6	5
9	2	1	-
8	2	-	2
7	1	-	-
6	-	1	1

NtMicro RGB module, application training and Quick Guide demo'd at OPG



Summary

RGB imagery can be created locally (i.e. client-side) from single band imagery already on the system with little impact given recommended change to texture cache in AWIPS II.
Training/Reference material accessible to forecasters within their operational display system improves RGB interpretation and application as demonstrated at OPG.
Application examples from experienced forecasters are needed to support the larger community use of RGB imagery and these can be integrated into the user's display system.